grass called *lalang* (*Imperata cylindrica*, Cyr.), which is not only useless, but very injurious, both by reason of its inflammability, and because it prevents any cultivation of the land covered by it, except with a great deal of labour and expense. Wherever the land is burnt or having been under cultivation is suffered to run to waste, it is soon covered with *lalang*, whatever may have been the previous vegetation, except where the soil is sandy, or wet, or shaded by trees. The treatment of the soil by chemicals, such as salt, sulphate of iron, &c., apart from the heavy expense connected with it, is liable to have a very injurious effect, even for many years, on the plants with which the ground is afterwards afforested. The introduction of some more actively growing plant to combat and destroy the *lalang*, has been proposed, but this would be to destroy one noxious weed by another still more noxious. When trees are tall enough to throw a shade upon the ground, the *lalang* quickly disappears, nor can it penetrate even into forest glades if but a few trees bar its progress. It is suggested, therefore, that shade trees and bushes should be gradually planted.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m., December 26 = 4h. 22m. 20s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G. C. 839	—	—	4 15 32	+19 7
(2) 47 Eridani	5	Reddish-yellow.	4 28 54	− 8 25
(3) ε Tauri	4	Whitish-yellow.	4 22 12	+18 56
(4) μ Eridani	4	White.	4 40 0	− 3 27
(5) R Leporis	Var.	Red.	4 54 36	−14 56
(6) U Geminorum ...	Var.	Variable.	7 48 34	+22 17
(7) Neptune, Dec. 26..	—	Greenish.	4 2 21	+18 59
,, Jan. 2 ...	—	—	4 1 44	+18 57

Remarks.

(1) This is described in the General Catalogue as an exceedingly interesting object, but very faint and small; according to Hind it is variable. I have not been able to find any record of its spectrum. Continuous observations over a considerable period, even with small dispersion, may throw light upon the nature of the changes which take place.

(2) A star of Group II., in which Dunér records the bands 2–8. Bands 2 and 3 are the strongest, indicating that the star is well advanced in condensation towards Group III. As in similar stars, dark metallic lines and lines of hydrogen should receive special attention, as the stages at which these make their appearance have not yet been determined.

(3) Vogel classes this with stars of the solar type, and the usual differential observations are suggested. (For criteria, see p. 20.)

(4) According to Konkoly, this is a star of Group IV. The usual observations of the relative intensities of the hydrogen and metallic lines are required, so that the star may be placed in line with others on the temperature curve.

(5) This is a variable star of Group VI., but the range of variation is small (6·5–8·5). The origin of variability in stars of this group has not yet been satisfactorily explained, and there is no record of the spectroscopic changes which accompany the changes in magnitude. Further observations are therefore necessary, and it is suggested that variations in the intensities of the carbon flutings should be particularly noted. The star was at minimum on October 23.

(6) This variable reached its maximum on December 21, and, as the period is only 86 days, observations may be made from maximum to minimum, providing that sufficient optical power is employed. The magnitude ranges from about 9 at maximum to 14 at minimum. The colour is stated to vary from white at maximum to reddish at minimum. The spectrum has been described as continuous (probably near maximum), but the colour-changes indicate that considerable variations in the spectrum may also be expected.

(7) The spectrum of Neptune was first observed by Secchi, in 1869. He noted that there were three broad dark bands, which were nebulous at the edges, and that there was a remarkable absence of red light. Vogel gave a more detailed account of the spectrum in 1872 (*Bothkamp Beobachtungen*, 1872, p. 71). The bands then recorded were as follows:—

Wave-lengths.		Remarks.
597	... ...	End of spectrum.
565·7	... ...	End of a wide dark band.
556	... ...	Very feeble band.
540	... ...	Middle of the darkest band.
518	... ...	Faint band.
513	... ...	,,
507	... ...	,,
485·8	... ...	Middle of a dark band.
477	... ...	Middle of a wide dark band.

The whole spectrum is very similar to that of Uranus. The proximity of the edges of some of the dark bands to the bright flutings of carbon and manganese led Prof. Lockyer to suggest that in Uranus and Neptune we might have to deal with the radiation of those substances, the dark bands being produced by contrast. Acting on this suggestion, I made observations of Uranus with a 10-inch equatorial, and afterwards, in conjunction with Mr. Taylor, with Mr. Common's 5-foot reflector. Direct comparisons certainly showed coincidences of the flutings of carbon with luminous parts of the spectrum. No solar lines were visible, but Dr. Huggins has recently photographed the spectrum, and found nothing but solar lines. In a recent observation of Neptune, I thought the bright flutings were more evident than in Uranus, but I have not had an opportunity of making comparisons. Further observations with reference to the existence of bright flutings are suggested. A. FOWLER.

VARIABLE STAR IN CLUSTER G.C. 3636.—Prof. Pickering writes (*Astr. Nachr.*, 2941) that photographs are being taken at Wilson's Peak, Southern California, with a telescope of 13 inches aperture. Four photographs, with exposures of about one hour each, were taken of the above cluster, whose position for 1900 is R.A. 13h. 37m. 35s., Decl. + 28° 52′·9. A star about twenty seconds south of the centre of the cluster was found to be much brighter on May 21 and June 8, 1889, than on May 31 and June 17, 1889. Two maxima seem to be indicated by the photographs separated by an interval, during which the star becomes comparatively faint. Visual observations made at Cambridge Observatory since June appear to confirm this variability.

CHANGES IN LUNAR CRATERS.—A few observations made by Prof. Thury (*Astr. Nachr.*, 2940), of craters in the terraced ring of Plinius, indicate some striking changes. On November 1, Plinius presented the same aspect as that described in 1882 by MM. Elger, Gaudibert, and H. Klein. Two craters, cutting one another, appear in the middle of the ring, and it is thought that one of these was not visible in the middle of September. The central opening seems to have been enlarged, for on November 1 its diameter was estimated as at least one-third of the total crater, whereas in September the diameter of the opening was rather less than one-fourth of the total diameter.

The interpretation put by Prof. Thury upon these appearances is that in the centre of Plinius there are two small craters, the aspect of which is modified by the different amounts of snow and ice about them. Emissions of heated gas and vapour would affect considerably the state of the lunar surface, for if, in the beginning of an eruption, water-vapour were predominant, it would be immediately condensed around the crater, forming a circular field of snow, so that the apparent enlargement of the opening may be due to the melting of the snow surrounding it by the hot gases emitted.

ON THE FUTURE OF OUR TECHNICAL EDUCATION.

LAST week we referred to an address delivered by Sir Henry Roscoe at Goldsmiths' Hall on Tuesday, December 17, after the distribution of the prizes and certificates to the students of the City and Guilds of London Institute. He spoke as follows:—

In his admirable address delivered last year on a similar occasion to the present, Sir Lyon Playfair pointed out that one of the important objects for which the City Guilds were originally founded was to develop and restore arts and sciences, and act as teachers to pupils. In the ancient charters the word "Universitas" is used for the modern designation of Guild. University simply means a teaching corporation, whether for professional or trade purposes. In both cases the teacher is termed a "master," and the pupil an "apprentice" from *apprendre*, to learn. The function of teaching by the Guilds was gradually lost. The master became the capitalist, the pupil the workman. The capitalist does not consider it part of his duty—quite the contrary—to teach the workman his craft, and thus the latter, though handy in one branch, never becomes a craftsman; intelligence is wanting, and the industry suffers when placed in competition with that for which the craftsman has been intelligently trained.

But now the Guilds have recovered their long lost ground, and by a natural process of evolution they are now engaged separately and collectively in nobly carrying out the work for which to a great extent they were originally constituted.

This new departure, or rather this recurrence to the ancient type, we know as technical education, and we define it as the instruction in those arts and sciences which underlie the practice of the industry or trade, this instruction being given in the technical school.

No attempt is there made to teach the trade or industry itself; this is done, and can only be done, in the factory or workshop. The school teaches how to make the best article; the workshop, how to make that article cheapest. The school ignores economical production, whilst this is the all-important factor in the workshop.

In my remarks this evening I propose to consider how the Guilds are now carrying on this work, and to point out the relation which that work bears to the general question of technical education in the country, which is now acknowledged on all hands to be one vitally affecting our industrial supremacy amongst the nations.

This acknowledgment has now received a national recognition in the passing of the Technical Instruction Act of last session of Parliament, and thus has materially changed the whole aspect of affairs. *Now* technical instruction, which has hitherto been sporadic may become systematic, for private effort has received national authorization, and sooner or later a complete scheme for technical instruction must be forthcoming.

The commencement of such a scheme has indeed already been made by the efforts of the City Guilds. Your Institute, with its various branches, is the nucleus of such a system, the importance of which will perhaps only be recognized when the history of this great educational movement comes to be written.

Starting from small beginnings, this work has already attained dimensions which exceed the most sanguine expectations of its founders.

The extension of your technological examinations has been so rapid that now no fewer than 12,000 students are receiving instruction in 500 registered classes in 113 towns in the Kingdom, whilst 6000 students passed the examinations last year.

Of the value of these examinations as stimulating a knowledge of the *rationale* of practical processes there can be no doubt. The age of empiricism is past, rule-of-thumb is dead, and a new rule, that of scientific training or organized common-sense, has taken its place.

These examinations serve to spread that scientific training amongst the masses of our population, and though they do not accomplish *all*, they accomplish much, and the classes if not all first-rate are still vastly better than none at all, and it is satisfactory to note that the employers of skilled labour are beginning to find out that the men thus trained are of greater value than those who have not had such training.

To quote one example of this among many, a pupil of the Manchester Textile School gained at the last examination the silver medal in honours. He was simply a "cotton operative," but since that time he has obtained the post of manager of 1170 looms under a large manufacturing firm, and the determining factor in his success over a great number of competitors was his possession of the silver medal first-class certificate in honours of this Institute.

But, after all, the attendance on these classes is only the beginning. A more thorough training is needed; for this the Institute has founded the admirable model "Intermediate" Technical School in Finsbury, where the course is a real preparation for entering the workshop, and thus the pupils begin industrial life under more favourable conditions than otherwise would have been the case.

It is much to be hoped that the Institute may not only be able to continue grants to this most useful school, but may see its way to plant other similar schools in various parts of the metropolis, which after all is the greatest industrial centre in the Kingdom.

But the Institute does not stand alone in carrying on this great work of raising up the true craftsman, and thus helping to keep down that danger to our overcrowded centres of population—the great army of unskilled labour. The Guilds are separately taking up the question, and if we may deplore the withdrawal of some from the general scheme, we may well commend their efforts in other directions. Witness the foundation by the Company in whose hall we are now assembled of a great technical and recreative institute at New Cross, which bids fair to become a centre of light and leading in a district dark and backward.

Again, look at what the Drapers' Company have done, and are doing, at the East End to place the People's Palace on a sound financial basis; or at the still greater work, if such things can be compared, which the Clothworkers' Company has done in Yorkshire and other districts to place upon sure scientific foundations the clothworker's craft.

Amongst these efforts to raise the industrial capabilities of our population we must not forget the scheme of the Charity Commissioners for the application of the property of the City of London charities. This arose out of an Act passed six years ago at the instance of my friend Mr. Bryce, which directed that the general funds of these charities should be applied to the benefit of the poorer part of the population.

No less a sum than £50,000 per annum is thus applicable, and the scheme lately put forward by the Commissioners for the appropriation of this sum is, on the whole, an admirable one, which may, if wisely worked, end in the creation of what may be termed a popular technical University for London. The value of such an organization as is thus proposed will be appreciated by those who have some knowledge of how these things are managed on the Continent, and in how chaotic a state is the whole of London education beyond the rank of the primary school.

All these efforts are truly "signs of the times;" they point to the recognition by the better endowed that not merely is it their duty, but their self-interest, to see that those who have the power know how to use it wisely, for it is on this that our national stability and progress depend.

But it is not enough simply to educate the craftsman; his employer needs it equally, if not more, and this task is, perhaps, a more difficult one, for as the Royal Commissioners on Technical Education report, "Englishmen have yet to learn that an extended and systematic education, up to and including original research, is a necessary preliminary to the fullest development of industry," and this necessity your Council have fully acknowledged, for, at the inauguration of your Central Institution, Lord Selborne said:—"It is, however, in the appreciation of, and in the facilities for higher technical instruction, that we in this country are most deficient, and it is to supply this want that the Central Institution has been established, . . . in which new and increased facilities will be afforded for the prosecution of original research, having for its object the more thorough training of the students and the elucidation of the theory of industrial processes."

I do not think that one could more emphatically or more clearly define the character of the work needed for the highest instruction of the future leaders of industry, than Lord Selborne has done in these words.

Now, the question arises, Is the Central Institution accomplishing the ends thus clearly marked out? It must be admitted that the supply of students has hardly been equal to the expectations formed by its friends at the outset. But if the work done is of a high class, and if those who come within its walls are there fitted for discharging the higher duties which modern industry requires, we may be satisfied, for the fact is that the demand for high-class technical instruction has yet to be created. Other difficulties beset this particular kind of teaching. One is that, as in many new institutions, the students enter ill-prepared, and thus the instruction is forced into elementary lines, and the time which can be given to higher work materially shortened.

A second, is that of hitting off the happy mean between the teaching of theory and that of practice, and in order that this essential may be accomplished, it is necessary that the teachers giving this higher technical instruction should be men who are well known and respected in their several professions, and not mere schoolmasters. In other words, that they shall know the practice as well as the theory of the subjects they profess. Such men, as far as I am able to judge, your Council has found in the present able staff of professors.

Then again, in measuring the success of such a College, it must be remembered that it is intended for the *élite* of the industrial world, and that, as individual attention must be paid to each student in the laboratories and drawing-offices, the highest technical instruction of crowds is impossible.

Little seems hitherto to have been done in the way of training technical teachers, and for the obvious reason that the demand for such is very limited, whilst that for competent men to enter a more practical career is great.

But whether the College is training teachers, or those who are to carry out the lessons of such teachers into practice, does not matter. The object is to train men who can improve our present industries, and raise up new ones; and this may be accomplished by either or by both methods. Neither the one nor the other can, however, succeed unless the student of technology has a firm grasp of the scientific principles upon which his industry is based.

It is useless, and worse, to attempt to teach the applications to pupils to whom the science itself is an unknown quantity.

Hence arises the question, How and where can the preliminary science training be best given? and the answer to this raises many difficult and some delicate matters.

First, however, let me disabuse your minds of a notion which may become general, and, if so, harmful—namely, the new Metropolitan Polytechnic Institutions, as they are called, can ever do this highest and most important kind of education. Do not let us fancy that the establishment of these no doubt very valuable institutions is the ultimatum to be aimed at in technical education, or imagine that they can attempt to do what is done in Germany, France, or Switzerland by institutions bearing the same name. I look upon it as a misfortune that, by mere chance, the name of the old Institution in Regent Street, known to fame as the home of the diving-bell and of Prof. Pepper's Ghost, should have been retained for institutions which neither resemble it nor the high schools which form so marked a feature in the Continental educational system. These latter are in our country rather represented by the scientific departments of our Universities, and by those of the metropolitan and local University Colleges, by the Royal Normal School of Science, and by your own Central Institution. We cannot too clearly understand that whatever success attends the foundation of these Metropolitan Polytechnics—and no one more cordially wishes them success than I do—the work of the centres of the highest education still remains to be done; indeed, the greater the popularity of the lower institutions, the greater the need and scope for the higher ones.

The rapid growth in London of this idea of the importance of handicraft and recreative education is most remarkable, and for this stimulus we are almost wholly indebted to Mr. Quintin Hogg.

The effect of this movement upon your Institute has been severely felt, for it is clear that, whereas seven or eight years ago the enthusiasm of the City Companies was strongly in favour of the higher technical education in the Continental sense, it is now all for this newer and more popular, I will not say less useful, form of handicraft and recreative instruction.

It is a fact which may as well be clearly stated, that the Central Institution cannot do all it might do for want of a few thousands, and that the scheme of technological examinations is crippled by the loss of the support of those who at first nobly contributed towards these objects.

The Drapers prefer to support more popular institutions at the East End, and the Goldsmiths do likewise in regard to their own institution at New Cross, so that there is no doubt that the interest formerly felt in the general and collective work of the Institute is distinctly on the wane.

Well, ladies and gentlemen, a consideration of these patent facts leads one to the question, How are these things to go on? Are we never to have "law and order"—about which we have heard enough in other matters—introduced into affairs educational?

And in what I am about to say, let me premise that I merely express my own individual opinion as an independent observer, anxious only for the success of the good cause which we all have at heart. Then may I say that I am dead against a cut-and-dried system of Governmental education such as we see in other countries? I am all for stimulating and developing local effort to local requirements, and it is because I am fully aware of the dangers of centralization, and desire to promote adaptability to local needs, that I gave my hearty support to the Government Technical Instruction Bill as amended in the House of Commons, in which the power of the locality to work out its own educational salvation is fully safe-guarded.

But holding these views I see clearly that there are things which can only be satisfactorily accomplished by a central authority.

That our primary education can only be properly conducted on a national basis has been admitted for more than a quarter of a century; so it will be with the higher or secondary education, whether technical, commercial, or professional—we *must* have a system. As I have said, the foundation of your Institute was the beginning of such a system for technical instruction; but has it not already outstripped the bounds of your control? Can it be satisfactorily worked in the future on its present lines?

Let us look at the matter from an independent point of view. We have now three Government Departments charged with educational work—the Education Department for Elementary Instruction, the Science and Art Department, and the Charity Commissioners. One of the most important steps which could be taken to bring these under effective control is the appointment of a Minister of Education, of Cabinet rank, who would be in close touch with every part of our now discordant educational system. But that is not the immediate question before us.

This refers more especially to the desirability of consolidating the Science and Art Department. As you know, this controls and stimulates, in what I think we may allow to be a satisfactory manner, the teaching of elementary science and of art throughout the country. Would it not conduce to the benefit of the country, if the Guilds' technological examinations were to be undertaken by the Department, and thus placed on a national basis? Several of the subjects now included in the Directory of the Department, on which grants are made, are of a distinctly technical character, and therefore no objection can be raised that the other subjects now under the Guilds Institute cannot equally well be placed under the Department.

The benefits which would thus accrue are great and palpable, the two systems of examinations in pure and in applied science would then work side by side without friction or overlapping, and the extension of the technical examinations would be easy and certain.

If this were accomplished, I for one would strongly urge the removal of the system of payment on individual results—a method in all cases to be deprecated, but one which is especially unsuited for testing the value of technical instruction. This can be much more certainly effected by ascertaining the efficiency of the whole class, of the teacher, and of his appliances, by inspection or otherwise.

If once we get rid of this system of payment on individual results in one set of subjects, we may look forward to its ultimate extinction in the others, and no subject seems so suitable for making a beginning as that of technical instruction.

I would therefore suggest that the best means of securing the permanency and the extension of the very useful technological examinations which your Council—and all honour to them for it—have started, is to request the Government to take them over, thereby rendering the Science and Art Department more efficient, and enabling that Department to make the improvements and alterations in the system which it undoubtedly requires.

May I go one step further in these suggestions, and ask if this should be done, is it not a necessary corollary that the Central Institution should likewise become a Government Normal School for Applied Science? There is much to be said in favour of such a proposal.

The very situation, close to the Royal Normal School of Science, seems to forecast its ultimate destiny. Under separate management, no consistent or well-arranged scheme of common work is possible; brought under one direction, the essential alliance between pure and applied science, as regards teaching, becomes easy of attainment.

Students would pass and re-pass from the one school to the other, obtaining at the one the knowledge of the scientific principles, and, at the other, that of their applications.

Of the national advantages of such a fusion there can, I think, be little doubt. England would then be in possession of an institution which might, for completeness and efficiency, both as regards the *personnel* and the appliances, soon be made second to none on the Continent, and worthy of the greatest industrial nation in the world.

Your Institute would thus set itself free to extend its influence in other directions, and could then concentrate its efforts on what is perhaps, after all, its most legitimate and most useful function—that of providing intermediate technical schools on the pattern of the Finsbury School, of which many are required in the metropolis.

The exact terms on which the Government would be prepared to take over this part of your work is a subject on which, of course, I cannot pretend to enter, but a satisfactory basis can, I do not doubt, easily be found.

Your Council would then feel that the great work which they have begun has been handed over in its full vigour to the nation, and that with the nation lies the responsibility of extending and perfecting the system which they have had the honour and the gratification of inaugurating.

I am aware that in making these suggestions, I have raised a somewhat burning question about which there may be difference of opinion, and my apology for this indiscretion, if one is needed, must be the importance of the subject, and the anxiety which we all feel that the technical education of our country shall be placed on a firm and enduring national basis.

A FIRST FORESHADOWING OF THE PERIODIC LAW.

IT is well known that the Newlands-Mendeleeff classification of the elements was preceded by the discoveries of certain numerical relations between the atomic weights of allied elements, due to Döbereiner, Dumas, and others; but what has been almost entirely ignored is the immense advance made by M. A. E. Béguyer de Chancourtois,[1] a French geologist of note, Professor at the École des Mines, who was the first to publish *a list of all the known elements in the order of their atomic weights.*

M. de Chancourtois embodied his results in two memoirs presented to the French Academy of Sciences in April 1862 and March 1863. These memoirs have never been printed *in extenso*,[2] but extracts from them, and additional notes relating to the subject, were published in the *Comptes rendus* for 1862 (liv. pp. 757, 840, and 967; lv. p. 600), 1863 (lvi. pp. 253 and 479), and 1866 (vol. lxiii. p. 24). The first note bears the date of April 7, 1862, so that there can be no doubt as to de Chancourtois's claim to priority in this important matter.[3]

I have in my possession a thin quarto pamphlet, by de Chancourtois, entitled "Vis Tellurique: Classement naturel des corps simples ou radicaux, obtenu au moyen d'un système de classification hélicoïdal et numérique" (Paris, Mallet-Bachelier,[4] 1863), which contains nearly all the extracts from the *Comptes rendus*, together with some additional matter. It contains, also, what is absolutely essential to the comprehension of de Chancourtois's ideas, the graphic representation of his system, which is not to be found in the *Comptes rendus.*

I propose to give here a translation of the first communication to the Academy, followed by certain explanatory comments and brief extracts from the other papers:—

"Geological studies in the field of research opened up by M. Elie de Beaumont in his note on volcanic and metalliferous intrusions (*émanations*) have led me, for the completion of a lithological memoir on which I am now engaged, to a natural classification of the simple bodies and radicles by a table in the form of a helix, founded on the use of numbers which I call *characteristic numbers* or *numerical characteristics.*

"My numbers, which are immediately deduced from the measure of the equivalents or other physical or chemical capacities of the different bodies, are, in the main, the proportional numbers given by the treatises on chemistry, these being reduced to half in the case of hydrogen, nitrogen, fluorine, chlorine, bromine, iodine, phosphorus, arsenic, lithium, potassium, sodium, and silver; in other words, I either divide the equivalents of these bodies by two in the system in which oxygen is taken as 100, or multiply by two the equivalents of the other bodies in the system in which hydrogen is taken as unity.

"On a cylinder with a circular base, I trace a helix which cuts the generating lines at an angle of 45°. I take the length of one turn of the helix as my unit of length, and starting from a fixed origin, I mark off on the helix lengths corresponding to the different *characteristic numbers* of the system in which the number for oxygen is taken as unity. The extremities of the lines thus marked off determine points on the cylinder which I call indifferently *characteristic points* or *geometrical characters*, and which I distinguish by the ordinary symbols for the different bodies. The same points will evidently be obtained if we take as the unit of length the $\frac{1}{16}$ of a turn of the helix, and mark off on the curve lengths corresponding to the numbers of the system in which hydrogen is represented by unity.

"The series of points thus determined constitutes the graphic representation of my classification, which may easily be traced on a plane surface by supposing the surface of the cylinder developed; by its aid I am enabled to enounce the fundamental theorem of my system: *The relations between the properties of different bodies are manifested by simple geometrical relations between the positions of their characteristic points.*

"For instance, oxygen, sulphur, selenium, tellurium, bismuth,[1] fall approximately on the same generating line, while magnesium, calcium, iron, strontium, uranium, and barium, fall on the opposite generating line. On either side of the first of these lines we find hydrogen and zinc on the one hand, bromine and iodine, copper and lead on the other; parallel to the second line we find lithium, sodium, potassium, manganese, &c.

"Simple relations of position on a cylindrical surface would be obviously defined by means of helices, of which the generating lines are only a particular case; hence, as a complement to the first theorem, we may add the following: *Each helix drawn through two characteristic points and passing through several other points or only near them, brings out relations of a certain kind between their properties; likenesses and differences being manifested by a certain numerical order in their succession, for example, immediate sequence or alternation at various periods.*

"In order to attain a greater degree of accuracy, it is necessary to discuss the results of different measurements with respect to the same body.

"One question is all-important in this discussion; it is to know if the divergencies which occur may have causes other than the error of experiment. I reply to this question in the affirmative.

"I think that here, as in all determinations of constants which we wish to compare, they must be reduced to the same conditions. This idea seems to me the indispensable complement to the notion of an absolute characteristic number. Once the existence of this absolute number or *numerical characteristic* guaranteed by the possibility of connecting it afresh with observed facts, certain limits of variation being allowed [*literally*, varying within certain limits], we promptly arrive at Prout's law, which presents itself as furnishing a means for reducing experimental observations to a comparable state by a series of trials, without this state being even a completely defined one, but, on the contrary, in order to be able to define it. The combination of this principle with the rules for alignment allow me to give the most striking form to my invention. I am thus led to formulate the table of integral numbers, which, as I must not omit to mention, exhibits under certain aspects the *résumé* of the work of M. Dumas on this subject.

"In the construction of this table I have had recourse to the determinations of specific heats, not only as a means of control, but also to find new numbers unattainable by the methods of chemical investigation. By adopting as the constant product of specific heat by atomic weight, the number which corresponds both to sulphur and to lead, I have deduced from the series of results given by M. Regnault, purely *thermic* quotients or numbers, which take their places on my alignments in the most felicitous way. I will only quote two examples: firstly, the number 44, obtained from the specific heat of the diamond, which finds its place on the generating line of the characteristic, 12, of carbon, by the side of the characteristic, 43, which corresponds to one of the equivalents generally accepted for silicon; and another

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[1] Wurtz ("The Atomic Theory," p. 170) and Berthelot ("Les Origines de l'Alchimie," p. 302) give a bare mention of de Chancourtois's name. Mendeleeff, in his Faraday Lecture (Journ. Chem. Soc., October 1889), couples his name with those of Newlands and Strecker, and shows greater appreciation of his work.

[2] M. Friedel, the eminent Professor of Organic Chemistry at the Sorbonne, has kindly procured for me the information that the original manuscripts of these memoirs are preserved in the archives of the Institut; I hope to be able to examine them at some future period.

[3] Mr. Newlands' first paper, chiefly devoted to showing that the numerical differences between the atomic weights of allied elements are approximately multiples of 8 was published on February 7, 1863 (*Chemical News*, vol. vii. p. 70); his second paper, in which he arranges the elements in the order of their atomic weights, was published on July 30, 1864 (*Chemical News*, vol. x. p. 39) See J. A. R. Newlands "On the Discovery of the Periodic Law," &c. (Spon, 1884).

[4] Now Gauthier-Villars.

[1] This is probably a misprint, as bismuth does *not* fall on the same generating line in the table.